Global Scientific JOURNALS

GSJ: Volume 10, Issue 12, December 2022, Online: ISSN 2320-9186
www.globalscientificjournal.com

PHYSIO-CHEMICAL ANALYSIS OF OIL SPILL IN THE NIGER DELTA

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ABSTRACT:

The issue of oil pollution is basic problem in the Niger Delta that affects the state of the economy. The study aimed to address the physio-chemical analysis of oil spill in the Niger Delta covering three local administrative districts of Karabari District, namely Asari-toru, Degema and Akuku-toru, which are located between 6°40' 0"E and 7°0'0"E, latitude 4°20'0"E. located between "N to 4°40'0"N. The specific objectives considered were to: (i) identify the nature of spill hazardous to the environment (ii) examine the relationship of the physio-chemicals and Satellite-derived temperature. The data set includes landsat image, soil, drinking water and

temperature data, others are ArcGIS 10.7 and excel software. Methodology comprises Gas Chromatography technique, rescaling measurement, multivariate analysis and graphical user interface created in MATLAB oil spill estimation. Some of the results from the test shows the presence of spill (0.06kg/L) in drinking water, (21400mg/kg) in soil and the classified map showed 67296.130ha of oil spill. The study also recommended that community youths engaged in illegal bunkering should put an end to bunkering due to the adverse effect.

1. Introduction

Buguma City is experiencing a spill on the surface of the seawater that is flowing from its creek to other parts of the Local Government Areas and it is considered as a pollutant. It also affects the underground water circulation, soil biochemistry on the other hand, lead to low crop output. The impact on the vegetation and mangrove are put to extinction. Aquatic mammals and fishes are reported dead within the locality. This calls for the attention of the Government to investigate the source of the fluid. Fishermen and women, who use the marine water as a means of sustainability to cater for their families, also bath with the water and observed rashes on their skin (Ordinioha & Brisibe, 2013; Grattan et al., 2011; Palinkas, 2012; Shreve, 2011; Ana et al., 2009) and the medical examination entails that the rashes are caused by the spill. Pollution is the evolution of polluting something or the state of being polluted (Hornby, 2018). Therefore, environmental pollution is the proportional mixture of the venomous level of chemicals in the air, water, and land. These chemicals neuter the environment and get involved with the functioning of the ecosystem to cause disturbance (Outlook, 2008; NOAA's National Ocean Service, 2018; Gathambo, 2002; Kampa & Castanas, 2008; Benka-Coker & Ekundayo, 1995; Benka-Coker & Olumajin, 1996; Holliger et al.,1997; Karaka et al., 2007; Amnesty International, 2009). The pollutant is considering gaseous, liquid or solid cannonaded into the environment because of human activities. Most pollutants pose a menace to the environment, and human health, and wellbeing.

The incident of Crude Oil was first discovered at Oloibiri in 1956, old Rivers State but now presently in Bayelsa State (Kadafa et al., 2012; Onuoha, 2007; Anifowose, 2008; Okoli & Orinya, 2013; Jack et al., 2016). The espial of oil in Nigeria brought about rejuvenation in the economic development of the country. However, studies have shown that crude oil exploration and exploitation also led to numerous adverse environmental impacts including environmental degradation, pipeline explosions, loss of life, economic losses, and pollution, particularly in the Niger Delta (Stanley, 1990; Inoni et al., 2006; Okoli, 2013; Chukwuma, 2013; Ifunanya, 2010; Yo-Essien, 2008; Vidal, 2011). Oil exploitation has resulted in numerous spill water incidents in the delta. The discharges are mainly Hydrocarbons into the water bodies, ice or on land through tankers, ships, and offshore installations (Lu, 2003; Lu et al., 1999; Ivanov, 2000; Ivanov et al., 2002; Grüner et al., 1991; Espedal & Johannessen, 2000). Apart from this, the spilt oil can also emanate from non-point sources, such as domestic, industrial, and runoff (National Research Council, 2003).

Pipeline breaks have been a significant wellspring of an oil slick where 16,083 episodes' account for as long as ten years while 398 customs fitted to bursts, unpatriotic occasions alone represented 16,685 breaks, which came about to 97.5% (Ogbeni, 2012; Kadafa, 2012; Federal Ministry of Environment, 2006). Ever since, vandalism has been on the expansion, which represents an issue to the oil business in Nigeria. The yearly report of the Nigeria Extractive Industry Transparency Initiative (NEITI), expressed that Nigeria lost 10.9 billion US Dollars to Oil robbery sometime in the year 2009 and 2011 (NEITI, 2013; Onoja, 2013; Pipelines and Products Marketing Company, 2015; Ikenna, 2015). This inferred Oil pipeline vandalism brings financial, natural, and philanthropic results in her generality (Onuoha, 2009; Onoja, 2013). It will be reviewing that Nigerian National Petroleum Corporation likewise experienced pipeline breaks somewhere in the range of 2010 and 2012 adding up to 157, 81 trillion of oil-based commodities worth 12.53 billion.

Fingas (2001) expressed that Marine Oil slicks are significantly more cancer-causing agent as wind, wave, and flows do disperse overflow an enormous region in an untamed ocean. Considering the state of dark colours in the marine and marine-related sectors, joint researchers additionally talk about the causes of the marine spill, where much oil drifted feathered creatures were discovered dead (Brown et al., 2006). The study brings in determination procedure and remote sensing technique to address the subject matter and the following objectives are put into consideration, they are:

1. To identify the nature of spill hazardous to the environment
2. To examine the relationship of the physio-chemicals and Satellite-derived temperature

2. Study Area

The study area includes three local administrative districts of Karabari District, namely Asari-toru, Degema and Akuku-toru, which are located between 6°40' 0''E and 7°0'0''E, latitude 4°20'0''E. located between ''N to 4°40'0''N (Fig. 1.1). Degema local government was established on May 27, 1967 and includes all Karabari-speaking communities. According to the census (2006), the population of the region is estimated at 249,773, the definition of land is a parametric measure, and its area is equivalent to 1,011 km². The headquarters of the Degema Local Government Area is Degema Town, which is listed in the Rivers State Government White Paper. Degema is the name of a clan that includes Usokun Degema and Degema City.

Economy Activity

The under study Local Government Areas are significantly connected to the Sambreiro River, which is a connecting rod to towns and seaports mostly Bonny via Boler Creek, New Calabar River, Kra-Kra Creek and Port Harcourt. The position of Sambreiro River became a source of attraction for all works of life for the traditional market centre. Products available at the centre are fish, casava, taro, palm produce, plantain and yams of the Ijaw people. After the downward of the slave trade in the early 19th century, they are known for their high export rate of palm oil and kernel within and outside the country (Britannica, 2019). However, exploitation of oil and natural Gas is another influence it has in the River Niger and Degema served by the General Hospital.

Vegetation and Topography

Oteiva and Ndokiari (2018) discussed that the vegetation in the Delta cuts across swarm, mangrove and tropical rain forest. They also stated that the Sombriero River evacuates the western part of Rivers state and it is around the swarm mangrove zone with tropical rain forest. The mangrove forest is typical vegetation found concerning the Sombrero River which includes complicated trophic level and violates the river at both banks consisting of mangrove trees (Rhizophora, Avicennia and Nypa fruticans) that form a characteristic muddy substrate that produces a foul odour which occasionally served as fuel wood for biodiversity. The land surface of the upland zone of Streams State is 20m over the mean ocean level (61%) where as the riverine region, for example, Asalga, Delga and Akulga, alleviation run from 2m to 5m, covering (39%) of the State. Labyrinth of rivers, lakes, creeks and swamps dominated the topography of the study area with low-lying plains (Environmental and Social Management Plan, 2015).

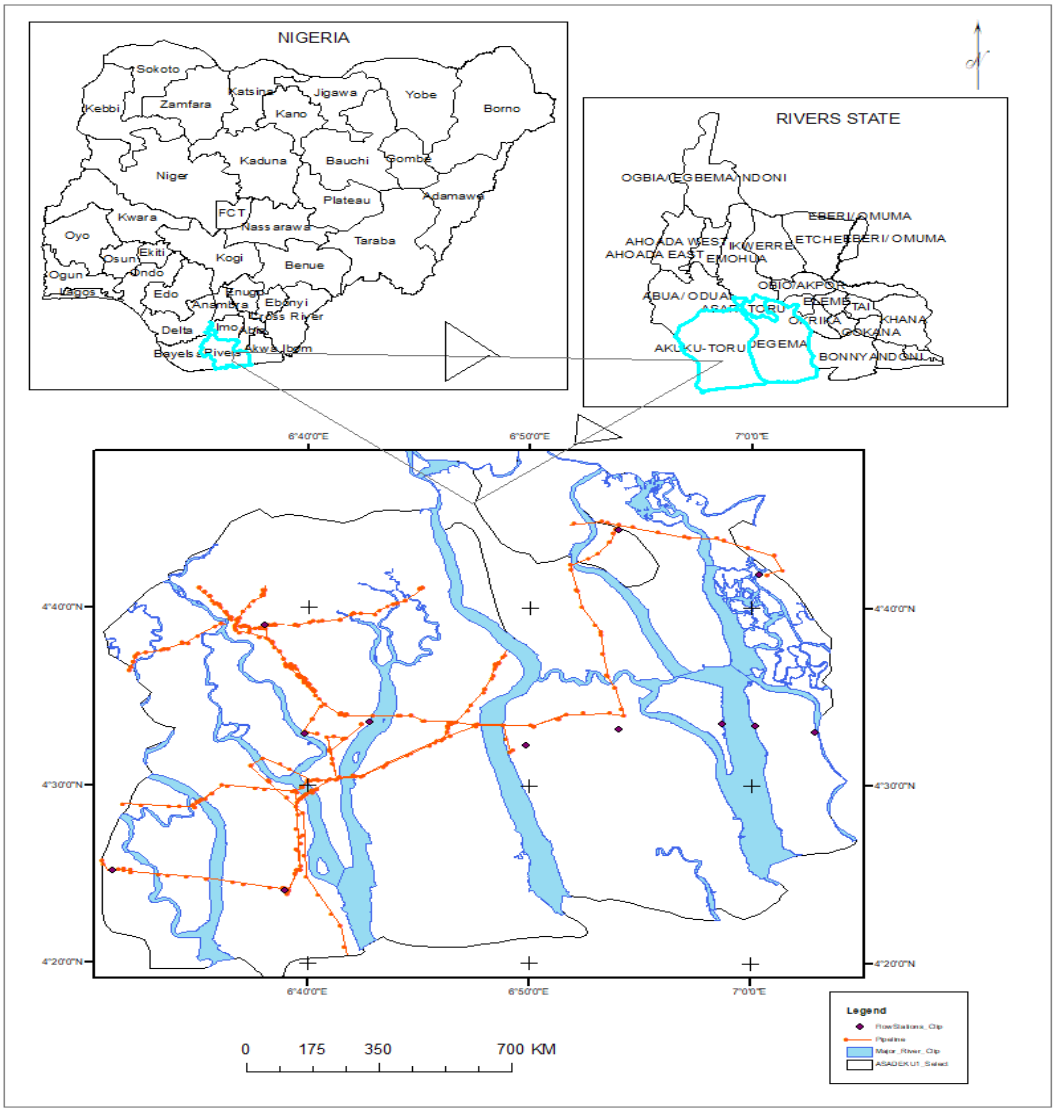

Figure 1.1: Map of the Study Area

3. Literature Review

An offshore oil rig activities, as has been dramatically demonstrated not only in the Macondo accident but in a variety of cases, pose the risk of a major accident with potentially severe consequences to the life, pollution of the environment, direct and indirect points to economic losses, and deterioration of energy supply security. The main hazards are: fire, caused by the ignition of released hydrocarbons, explosion, caused by the release of gas, formation and ignition of an explosive cloud, and oil release or hydrocarbon on the sea surface or subsea (European Commission Joint Research Centre Institute for Energy and Transport, 2012, Akpofure et al., 2000; John & Cheryl, 2001; Woods, 2011). They explained that on April 20, 2010, the Macondo well blew out, killing 11 men and igniting a disaster that sank the Deepwater Horizon drifting rig and spilled over 4 million barrels of crude oil into the Gulf of Mexico. The spill disrupted an entire region's economy, harmed fisheries and critical habitats, and highlighted the dangers of deep-water drilling for oil and gas. Under high pressure, methane gas from the well shot all the way up and out of the drill column, expanded onto the platform, and then exploded and platform was then engulfed in flames.

According to Andrew (2013), chemical concentrations that are deemed to pose a minimal risk based on the responses to controlled exposures may actually represent an underestimation of risk in the real world, where synergistic interactions with frequently occurring natural stressors may greatly increase the risk of chemically-induced damage (Sih et al., 2004, Zelenke et al., 2012; Prasad et al., 2014). Ecotoxicological risk and damage evaluations usually underestimate the type and degree of consequences because toxicant stress can be amplified by naturally occurring stressors (Heugens et al., 2001). Toxicity pathways vary by species, but some examples include absorption of oil, accumulation of pollutants in tissues, DNA damage, and immune system effects. Functionality, cardiac malfunction, a high rate of egg mortality, and Loss of buoyancy and insulation in birds, for example, and larvae in fish vapour inhalation is a term used to describe the act of inhaling vapours (Aguilera et al., 2010, Judson et al., 2010, Major & Wang, 2012).

Further review by Andrew (2013) independently studied the oil spill Deepwater Horizons (DWH) where 200 million of gallons in South Louisiana released into marine water, the pollutants of the spill caused which are mainly hydrocarbon that disturb the aquatic habitations, residents of the ocean area in a deplorable condition and the study is also in agreement with other leading authors (Silliman et al., 2012; White et al., 2012; Whitehead et al., 2012; Dubansky et al., 2013; Gomal et al., 2021). In the case of pollutants, laboratory-based studies of chemical exposure are normally conducted under ideal environmental conditions, such as optimal temperature, salinity, oxygen availability, predator absence, and minimal competition (Andrew, 2013). Changes in exposure routes may be linked to some interactions between oil toxicity and ambient salinities. In low-salinity environments, for example, PAH solubility increases as salinity decreases, increasing bioavailability and hazardous risk. On the other hand, fish in hyper-osmotic environments may increase their water inlet, which could perhaps increase the interaction of their intestine with dissolved organic pollutants in saltwater (Ramachandran et al., 2006; Puga et al., 2009). The ultra-violet (UV) light can alter the toxicokinetic of PAHs and increased UV exposure can drastically increase the harmful effects of certain oils, posing a risk to creatures living in shallow habitats (Incardona et al., 2012a; Incardona et al., 2012b). In all, DEB theory is framed as a developmental process, and it has been beneficial for simulating the physiological effects of chemical combinations (Kooijman 2001; Baas et al., 2010).

Elzbieta et al., (2010) while conducting spectrofluorometric measurements and analysis in a polluted site in the United Kingdom, observes the presence of zinc (Zn), lead (Pb) and cadmium (Cd) contaminants in mine association in chlorotic squatters that endanger the community of food deprivation. In a similar way, Enegide and Chukwuma (2018) whose research depend on the pollution in the Delta spot around the seventy's, roughly 3.1 million casks where enriched in manganese (Mn), iron (Fe), copper (Cu), zinc (Zn), lead (Pb), nickel (Ni), cobalt (Co), cadmium (Cd), and chromium (Cr) were leaked in the Delta region. As a result, residents of this area may be exposed to heavy metal toxicity (Tuelo, 2021). Chukwunoso et al., (2017) result on pollution in the Niger Delta is also confirming the amounts of lead (Pb), arsenic (As), and cadmium (Ca) in the samples collected using atomic absorption spectrophotometry. The contents of all three heavy metals in the test and control water samples were significantly (Probability value less than 0.05) higher than the World Health Organization's maximum contamination values.

A good number of literature outlines active and passive sensors as a device for detecting pollutants in space. In order to track pollution in the sea, active sensors emit electromagnetic waves. The signal is modified on the water surface, and the sensor detects the reflected signal. Active sensors have the advantage of being able to take measurements at any time, regardless of the day or season (Kristina & Vaidotas, 2016). The discovery of the satellite geodesy brings a lot of researchers in the application of the satellite imagery for needed research study (Buono et al., 2015, Xu et al., 2013, Fingas & Brown 2014).

Pirooz and Aghajanloo (2014) Swotted oil spill conduct within the Marine division (Tehran, Iran). The inquire about centered on the point of displaying three-dimensional numerical nature of oil spill in Iran. Multifactorial methodologies include within the demonstration preparation. The demonstration portrays it bases on the Eulerian approach, and the administering conditions, counting limited volume strategy. Other sub-principal models such as weathering forms and oil scattering in the water column are among the conclusive handle, to uncover the transportation of the spill. Visual Fortran dialect is utilized to code all show parameters of oil spill methods. These demonstrate permit computational space to partition into sectional divisions, and scientific conditions to cure layer issues. Sigma arrange is the arrangement to the vertical space discrete, due to shifting water profundity, marine foot rise, and water surface undulation. Genuinely, owing to the complexity of the models, even network, the water column is part into several layers, and vertical computational lines are imposing. The comes about are work of advection-diffusion, which demonstrated speculative oil spill utilizing Eulerian arithmetic rule, smooth development, weathering, and the scattering.

In a likewise manner, Foudan and Menas (2001) investigated the relevance of "Hyperspectral Image Analysis for Oil Spill Mitigation". The research is aimed at an accurate determination of

Oil spill hazard areas in Chesapeake Bay's (United State of America). The study was aided by the following materials to make realistic and they contained airborne and space-borne satellite, coupled with Environment for Visualizing Image (ENVI) software, pictures at the scene of the spill, and Remote Sensing spectral Angle Mapper Image classification was adopted for the study to identify oil spills in the water and shoreline. The signature matching principle engaged the extraction of the land use and land cover dynamics within the study area. Results indicated over two hundred (200) selected wavelengths of reflected and emitted energy were used to characterize oil from look alike. Four leading depressions were used to represent absorption at a wavelength of 400 and 700 micrometres (µm).

4. Materials and Method

4.1 Physio-Chemical Test

To find a solution to the damaging river, a drinking water sample was collected from a well at George –Ama in Asari-Toru Local Government Area. The study carefully looked at the direction of the flowing liquid in the swamp and collected a sample of the dark liquid. Thirty metres away, a soil sample was further collected and taken to Rivers State University, Port Harcourt to know the content of the samples collected ravaging the ecological state. The soil sample was dried and referenced to a control, including the water sample, where experimental Gas Chromatography technique was employed for detailed analysis of hydrocarbon elements present. The samples were analysed according to the World Health Organization standard and results presented for the study to be acquainted with the physio-chemical state of the samples collected.

4.2 **Satellite Image Classification**

Image classification is achieved after due composition of the ETM Landsat 7+ image of 30 metres spatial resolution of 2021, where five land use and land cover types were made in their respective order.

4.3 **Radiance Measurement**

The improved ETM LandSat 7+ imagery was converted to radiance (equation 4.1) and raster calculator in ArcGIS 10.7 was used to convert radiance to top of the atmosphere, using rescaling model to extract the temperature of the study area (equation 4.2 & 4.3).

$$L_{\lambda} = ML \times Q_{cal + AL} \quad (4.1)$$

where,

L_{λ} = TOA spectral radiance (Watts/ (m2 * srad * µm))
M_L = Band-specific multiplicative rescaling factor from the metadata (Radiance_Mult_Band_x, where x is the band number)
A_L = Band-specific additive rescaling factor from the metadata (Radiance_Add_Band_x, where x is the band number)
Q_{cal} = Quantized and calibrated standard product pixel values (DN)

$$TB = TB - 273 \quad (4.2)$$

where,

TB = Temperature in Kelvin

$$TB = \frac{K_2}{I_n\left(\frac{k_1}{L_\lambda}\right)+1} \quad (4.3)$$

where,

K_1 = Prelaunch calibration constant for band 10

K_2 = Prelaunch calibration constant for band 10

$L\lambda$ = Radiance Image

4.4 **Multivariate Analysis**

This is the combination of many data set in relevance to the study at hand. The method allowed the integration of polygon spill, physiochemical properties of both drinking water and soil, including temperature derived from Landsat imagery. The combing power is made possible through the use of excel software package to run multiple regression analysis and analysis of variance (One -way ANOVA), using its result to make wise decision in the specific objective.

5. Results and Discussion

5.1 Naure of Spill Hazard

The nature of oil spill hazard is given in Table 5.1 and Table 5.2 after due diligence to sample collections of well water and soil, and analytical procedures in the research laboratory of Rivers State University, Port Harcourt. The chemical method is adopted to make the study reliable and also to know the particles of hydrocarbon which will be an input value in the Geographical Information System (GIS) environment.

Table 5.1 is containing physiochemical analysis of drinking water in the selected areas of the study (Asalga, Delga and Akulga). A physio-chemical parameter study is very important to know about the quality of water and compare the results with different physio-chemical parameter standard values. The physio-chemical parameters such as pH, conductivity, turbidity, Ca (calcium) and Mg (magnesium) hardness, total hardness, total hydrocarbon content (THC), and total dissolved solid parameters are not in the limit when compared with (WHO, 1992) standards. Potential Hydrogen (pH) of a solution refers to its hydrogen ion activity and is expressed as the logarithm of the reciprocal of the hydrogen ion activity at a given temperature measured per litre. WHO (1992) standard stipulates 6.25-8.5 per litre for well water but a result of the potential hydrogen showed 6.25 per litre within the limit of the study. For more than six decades, the World Health Organization has developed and issued drinking water quality guidelines. Based on the available information on the risks associated with water consumption, these guidelines have become the universal benchmark for setting drinking water standards. The presence of carbonate may lower the values of pH to cause tuberculosis but higher values may also produce encrustation, sediment, deposition, and chlorination for disinfection of water. The total hardness is the quantity of calcium carbonate dissolved in water. The value obtained is 150mg/l against 500mg/l for standard regulation in Table 5.1 below. The physiological disorder may be prevalent as it affects the different body organs. Water is used for different purposes such as washing, bathing, cooking and hard water is not the best for all.

Temperature is the degree of coldness and hotness of a particular place. The temperature for the drinking water is seen to be 25.5°C and the standard temperature range is (0-30°C). Turbidity is the measure of the transparency of the fluid (unit of measurement include Nephelometric Turbidity Unit- NTU). The average value of NTU observed in the experimentation is 12 less than World Health Organization standard requirement of 50.

The ability of water to carry electric current is measured by its electrical conductivity. Water's electrical conductivity is proportional to the amount of dissolved mineral matter in it. A surplus of dissolved salts due to the addition of table salt in food products, real salt found in pure water, and other mineral discharges maybe the cause of conductivity. The conductivity value is found to be 180 μs/kg while (WHO, 1992) show 1000 for a world regulation.

Total Dissolved Solids (TDS) is the concentration of solid particles in the water sample. The result of the study reveals 98kg/l which exceed the WHO guideline of 50kg/l for the prevention of aquatic organisms. The research indicates that the high value of 98kg/l may be dangerous for fishes and other aquatic mammals.

The presence of heavy metals in their order of magnitudes are also observed in the study. They are calcium and magnesium which measure in milligram per litre (mg/l). The calcium ion recorded 21kg/l against 30kg/l for WHO standardization, in the same vein, magnesium ion presents in the water is 32kg/l against World Health Standard of 75kg/l. However, these heavy metals may cause pollution to aquatic and human health.

Total Hydrocarbon Content (THC) is an organic compound consisting of carbon and hydrogen atoms only. The research found 0.60kg/l of hydrocarbon content in the drinking water measured against 0.007kg/l recommendation (WHO, 1992) and the summary of Table 5.1 mentioned is given below concerning the detection of spill in various medium and the results show that:

1. Spill in drinking water is high
2. Turbidity is acidic
3. Total hydrocarbon content (THC) is very high

In other to still find a solution to the spilling issues in the study environment, a soil sample was collected at the polluted area and put inside a test-tube at room temperature for further detection of an oil spill if any, using standard means of measurement, precisely using the World Health Organization standards without any unbiased attitude. The potential hydrogen (pH) in the soil sample (test result) brings 5.35 per litre in comparison with 6.54 per litre for the control mechanism. The moisture content in the soil sample indicates 2.85 per cent while the standard control is 5.15 per cent (Table 5.2).

Heavy metals such as Nitrogen and Phosphorus are measured in milligram per kilogram (mg/kg). Nitrogen release 24.6kg/l out of 40.18kg/l in the standard unit of measurement. Secondly, phosphorus accounts for 22.8mg/kg again-stand of 31mg/kg of the world requirement. Both flows are causing widespread water pollution, degrading numerous soil layers, rivers and disrupting coastal oceans by creating what is termed hypoxic “dreaded zones”. Thirdly, total petroleum hydrocarbon is 21400mg/kg gain-stand 15mg/kg while organic carbon is 5.02 high in the analytical result. Heavy metal contamination has negative effects on a variety of plant quality and yield parameters, as well as changes in the scale, structure, and behaviour of the microbial population. As a result, heavy metals are regarded as one of the most significant causes of soil contamination. Various metals, especially carbon and phosphorus, cause heavy metal contamination of the soil. Heavy metals have an indirect effect on soil enzymatic activity by altering the microbial community that synthesizes enzymes. Heavy metals have toxic effects on soil biota by interfering with key microbial processes and reducing the number and activity of soil microorganisms. The summary of the discussion is given below as indicated in Table 5.2, for the detection of spill in the strata of soil:

1. The Soil is acidic
2. The Total Petroleum Hydrocarbon is very high

These results show that the nature of the spill ravaging the environment is petroleum hydrocarbon spill which stands to justify the first objective after different means were employed to ascertain the nature of pollutant in the neighbourhood of Kalabari Kingdom.

Table 5.1: Physio-chemical Analysis of Drinking Water

S/N	Parameters	Test Result	Standard (WHO, 1992)
1	Temperature °C	25.5°C	0-30
2	PH	6.25	6.25-8.5
3	Conductivity μs/kg	180	1000
4	Turbidity (NTU)	12	50

5	Total Hardness mg/l	150	500
6	Total Hydrocarbon Content mg/l	0.60	0.007
7	Calcium mg/l	21	30
8	Magnesium mg/l	32	75
9	Total Dissolved Solids (TDS) mg/l	98	

Table 5.2: Soil Sample of the Study Area

S/NO	Parameters	Test Result	Control (WHO,1992)	Spill Coordinate, Eastings(m)	Spill Coordinate, Northings(m)
1	PH	5.35	6.54	264148	521724
2	Moisture Content %	2.85	5.15		
3	Total Nitrogen mg/kg	24.6	40.18		
4	Phosphorus mg/kg	22.8	31.00		

5	Total Organic Carbon	5.02	4.15		
6	Total Petroleum Hydrocarbon mg/kg	21.4×10^3	15.0		

5.2 Image Classification

Image classification is carried out according to five land use and land cover, they are oil spill, water body, built-up, vegetation and cloud cover. Figure 5.1 demonstrates the classified map of the study area and 21.85% is recorded in 2021 with a total spill of 69296.13ha.

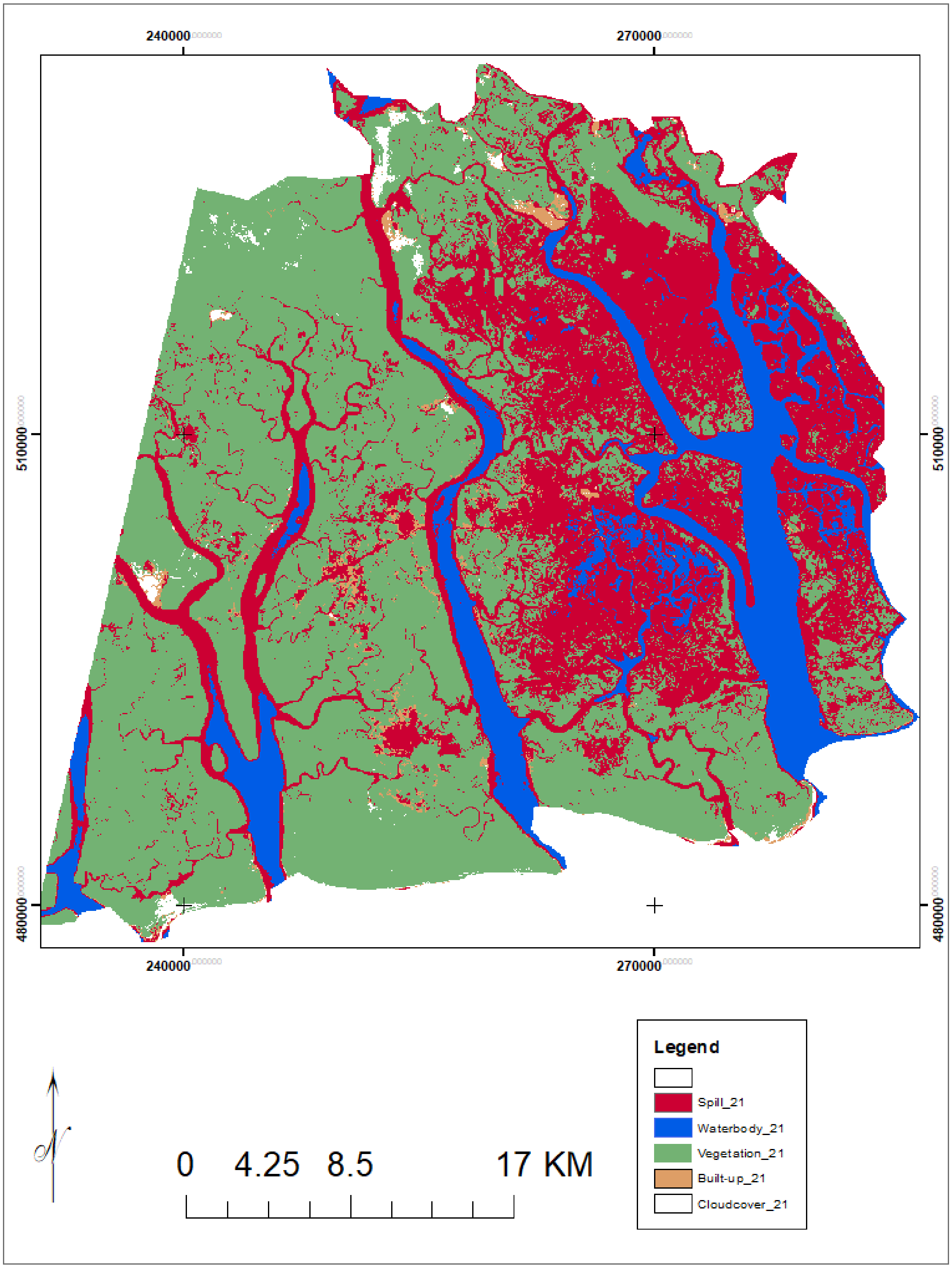

Figure 5.1: Classified Map for 2021

5.3 **Confusion Matrix for 2021 Classification**

The error matrix for 2021 classification is tabulated in Table.5.3 which comprises five land cover types under due investigation. The results show that spill has 0.8921 pixels for error of commission, 0.0040 goes for waterbody and built-up gained 0.0065 pixels. Meanwhile, the error of omission in the side of the spill shows 0.1755 pixels, 0.0881 pixels for waterbody and built-up is 0.3431 pixel. Nevertheless, the overall kappa index in the classification development is **72.56** percent which is above the minimum requirement.

Table 5.3: Error Matrix Analysis for 2021 Classification

Category	Spill	Waterbody	Vegetation	Built-up	Cloud Cover	Total	Error of Commission (c)
Spill	512	2550	1056	626	0	4744	0.8921
Waterbody	106	26378	0	0	0	26484	0.0040
Vegetation	1	0	4531	573	12	5117	0.1145
Built -up	2	0	0	4002	24	4028	0.0065
Cloud Cover	0	0	80	891	88	1059	0.9169
Total	621	28928	5667	6092	124	41432	
Error of	0.1755	0.0881	0.2005	0.3431	0.2903		0.1429

omission(O)							

5.4 Multivariate Analysis

Multivariate analysis (MVA) is a set of statistical techniques used for the analysis of simultaneous data that contain more than one outcome variable. It is the background that shows how variables are related to each other. Sometimes it is best solved through the approach of parametric and non-parametric aspects of statistics. The MVA considered polygon spill, physio-chemical properties of both drinking water and soil, also integrated is the satellite-derived temperature in the area of oil pollution (Table 5.4). The study decided to use an excel software package for the rigorous calculations using the multiple regression techniques to handle multiple data to decide on the study area. Look at (Table 5.4), the relationship that exist between the soil parameters and temperature in the correlative bar is 0.360 modest positive correlation. The drinking water (well) and temperature is having (-0.155) inverse correlation. Thus, the spill and temperature equally transmit a strong correlation of 0.553 in the univariate analysis. While interpreting the result, it means that any change in one unit will automatically lead to a corresponding change in the other unit of study.

Secondly, in the multiple analysis, results emanating from the study showing a multiple regression (R) value of 0.585 indicating a strong correlate and R square (R^2) is equal to 0.342 (34.2%), measuring the impact of change in the independent variable on the dependent variable and this act of description is called the coefficient of determination (Table 5.5). Others from the same table are the total unit of seven (7) observations, adjusted R square value of 0.210, standard error (Se) of 1.82 and sum of squares of the standard error (SSE) of 36055.06 were observed from the analysis, which can be also be modelled in the analogue process. The study resultantly shows a standard error (Se) of 1.82 from Table 5.5 that provide a measurement of equivalent distance, that the point fall from the regression line on average or could be used to predict model's using a dependable variable.

Multiple regression calculations are lengthy, fortunately, the study further looked at the ANOVA table (Tables 5.5 and 5.6) to buttress the study. It involves the degrees of freedom (df), the sum of squares (SS), mean square (MS), significance F and F-distribution. The fisher (F) distribution is a condition equation that says that when the F calculated (2.5951) is less than the tabulated (4.35), there is a need to decide and this also hints that when F calculated is greater than tabulated, there is also second decision to make in line with the study. The value of F tabulated is an achievement from critical values of the F distribution at a five (5) percent level of significance. Therefore, 4.35 is accepted against 2.5951 for a decision which proves a relationship between the variables. The obtained results in Table 5.6 can be explained as follow:

1. Sum of the square of regression = 3373597206.808
2. Sum of square of error = 6499839936.049
3. Total = 9873437142.857
4. Mean square of the regression (SSR) = 3373597206.807
5. Mean square of the error (SSE) = 1299967987.209
6. $F = \frac{SSR}{SSE} = 2.5951$ (5.15)
7. Significance of F = 0.168108

The significance result is expressing that the smaller the value of F (0.168108), the better the regression or correlation or more accurate the model. Nevertheless, the original regression model is given below to enable explain the variables.

$$Y = a + B_1X_1 + B_2X_2 + B_3X_3 + B_NX_N \quad (5.1)$$

where,

a = constant

B_1 = coefficient of X_1

B_2 = coefficient of X_2

This implies that the regression equation can be recreated as seen in equation 5.15.

$$\mathbf{Y = 5.35 + 29955.31X_1 + 2.9334X_2} \quad \mathbf{(5.2)}$$

where,

Y = Quantity of spill

X_1 = Variable for drinking water

X_2 = Variables for soil

The equation 5.2 is used to create a graphical user interface in MATLAB for oil spill location determination, to give a quantitative result. The coding is represented in appendix 1.

Table 5.7 is a measurement for the standard error of estimate which measures the dispersion of observed values of the dependent variables, around values predicted by the regression model. This is an indication of the reliability of the model about its values. The results have five negative values for both the residuals and standard residuals while the rest are two positive values (Figure 5.2), each of these two variables input in the model will thereafter produce a predicted result in equation 5.2 and figure 5.3. In the first (1) observation made, the residual is (-14663.7) and the standard residual value rises to (-0.44552) while the predicted is (29963.67) using the new regression model described above. This procedure is repeated up to the seven observations. The residual of the fourth point is indicating (-17370), standard residual (-0.52775) and the predicted value is 29970.04. The last point shows an estimated value of 29955.31 while the residual and standard residual are (3344.689) and (0.10162). The study highlight that the residuals are also known as a random error in term of the population regression model. The inclusion of the random error allows all the variables to fall either above the true regression line or below so that independent variable can be scattered around the regression line. Figure 5.4 is a normal probability plot of standard residuals for adsorption of data and fitted model. The straight like curve of the plot is a normally distributed random deviation.

Table 5. 4: Multiple Regression

Spill (M^2)	Well Properties	Temperature (°C)	Soil Properties
36000	6.25	23.4232	5.35
15300	180	23.4715	2.85
2700	12	23.5415	24.6
15300	150	23.6355	22.8
12600	0.6	23.7368	5.02
92700	21	23.8211	21400
100800	32	23.8211	25.5
33300	98	23.8836	0

Table 5.5: Multiple Regression Statistics

Multiple Regression (R)	0.5845

R Square	0.3417
Adjusted R Square	0.2100
Sum of square of Standard Error (SSE)	36055.07
Standard Error (S_e)	1.82
Observation	7

Table 5.6: ANOVA Analysis

	df	SS	MS	F	Significance F
Regression	1	3373597206.808	3373597206.807	2.5951	0.16811
Residual	5	6499839936.049	1299967987.209		
Total	6	9873437142.857			

Table 5.7: Residual Output

Observation	Predicted 36000	Residuals	Standard Residuals
1	29963.67	-14663.671	-0.4455
2	30027.47	-27327.473	-0.8303

3	30022.19	-14722.193	-0.4473
4	29970.04	-17370.036	-0.5277
5	92731.2	-31.202	-0.0009
6	30030.11	70769.886	2.15016
7	29955.31	3344.689	0.1016

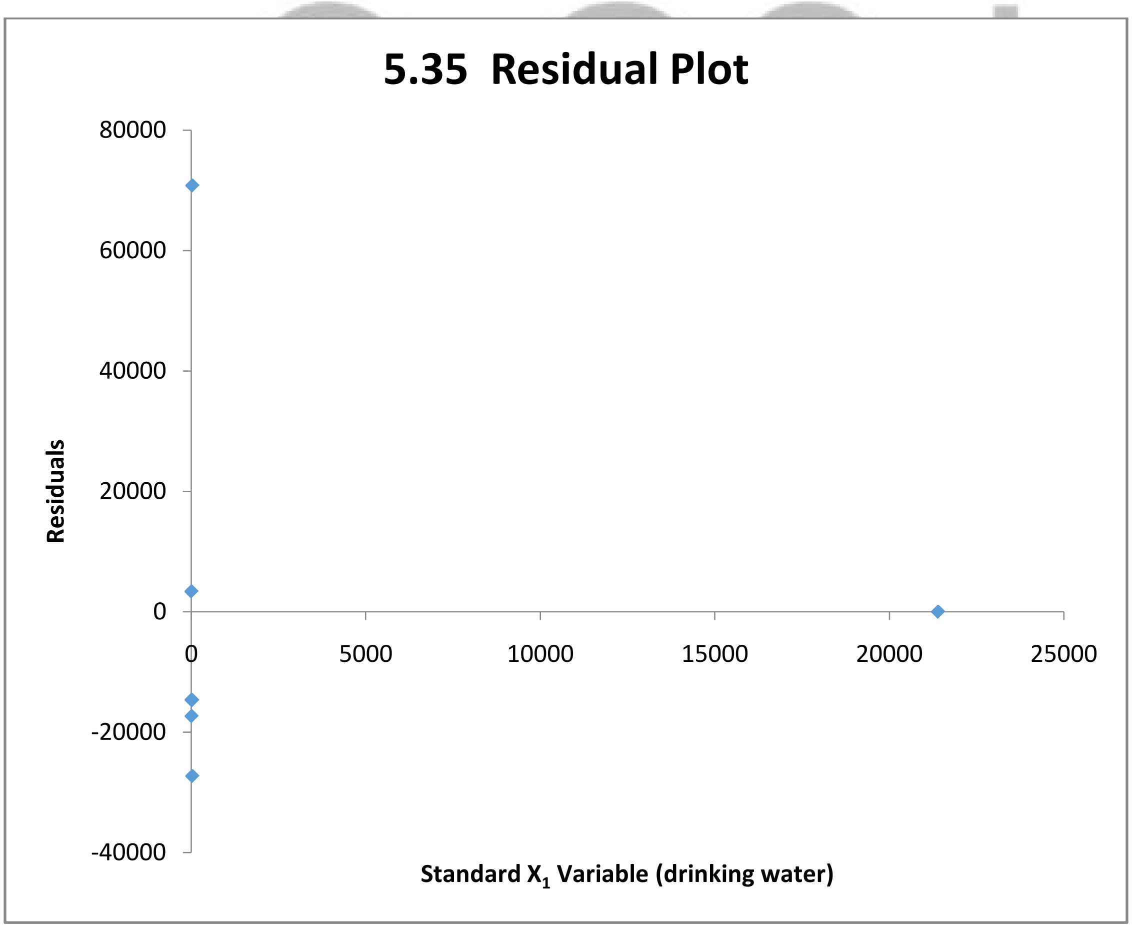

Figure 5.2: Residual Plot

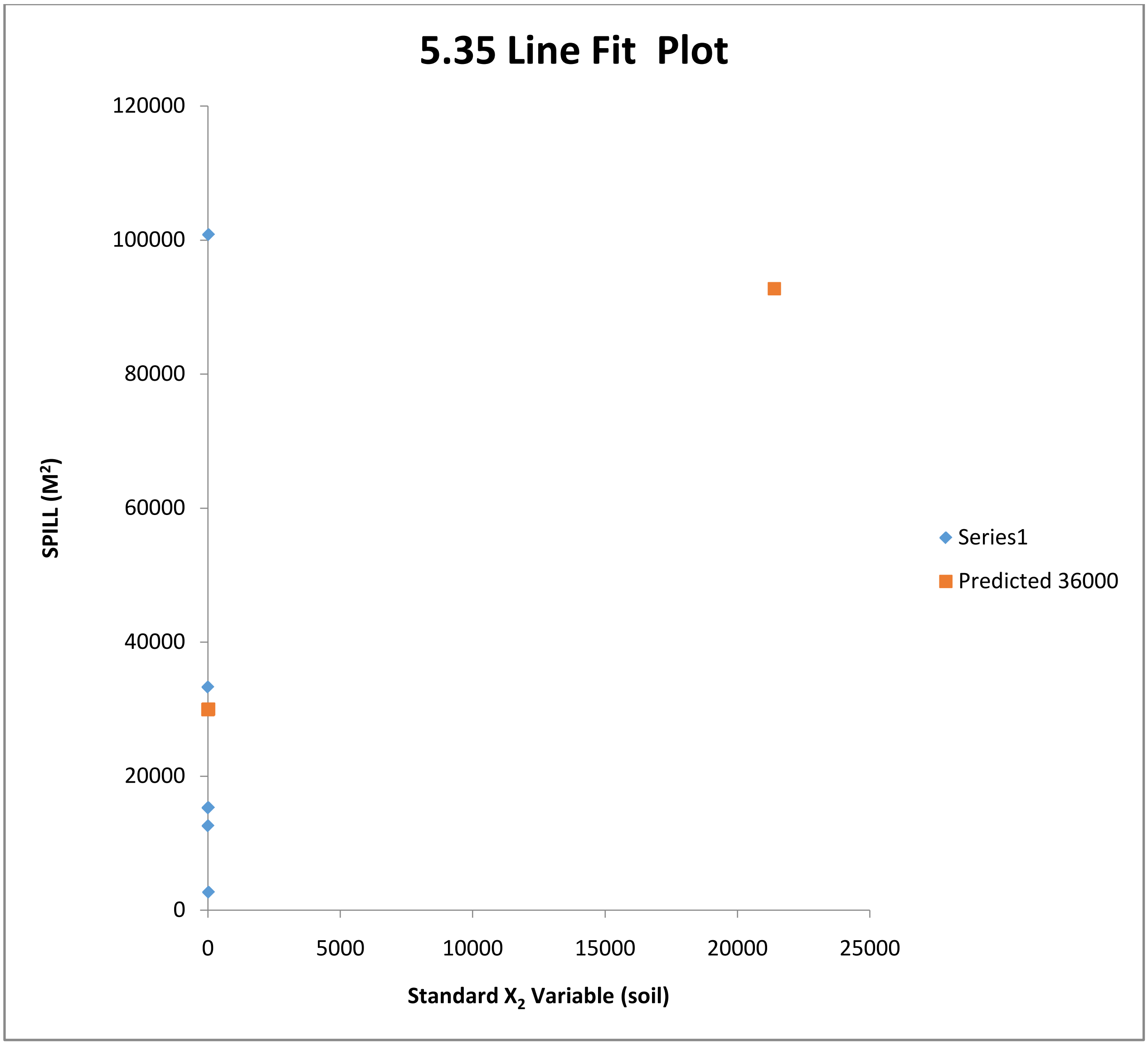

Figure 5.3: Standard Line Fit Plot

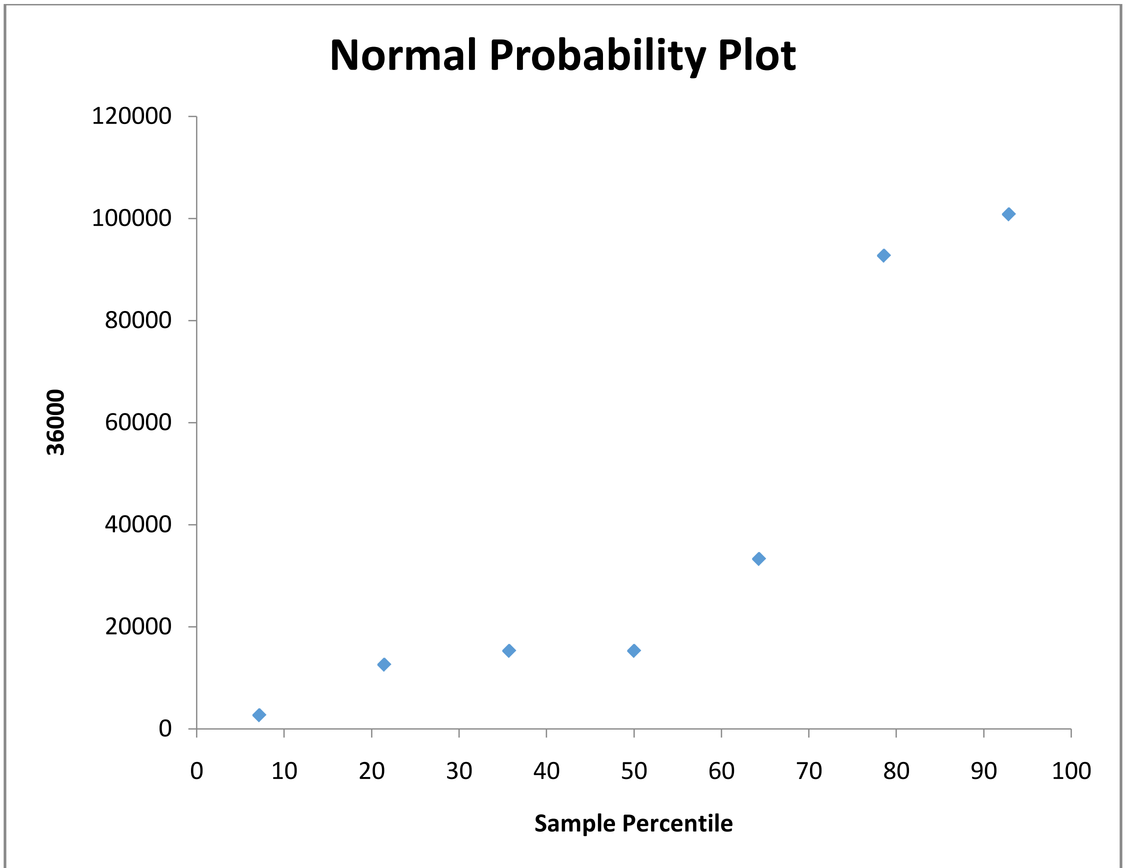

Figure 5.3: Normal Probability Plot

APPENDIX F1: OIL SPILL QUANTIFICATION USING MATLAB

MATLAB CODE: QUANTIFICATION OF OIL SPILL

```
classdef SJ < matlab.apps.AppBase
    % Properties that correspond to app components
    properties (Access = public)
        UIFigure           matlab.ui.Figure
        X1EditFieldLabel   matlab.ui.control.Label
        X1Edit             matlab.ui.control.NumericEditField
        X2EditFieldLabel   matlab.ui.control.Label
        X2Edit             matlab.ui.control.NumericEditField
        YEditFieldLabel    matlab.ui.control.Label
        YEdit              matlab.ui.control.NumericEditField
        ComputeButton      matlab.ui.control.Button
    end
    methods (Access = private)
        % Button pushed function: ComputeButton
        function ComputeButtonPushed(app, event)
```

```
            x1 = app.X1Edit.Value;
            x2 = app.X2Edit.Value;
            Y = 5.35 + 29955.31*x1 + 2.9334*x2;
            app.YEdit.Value = Y;
        end
    end
    % App initialization and construction
    methods (Access = private)
        % Create UIFigure and components
        function createComponents(app)
            % Create UIFigure
            app.UIFigure = uifigure;
            app.UIFigure.Position = [100 100 641 326];
            app.UIFigure.Name = 'UI Figure';
            % Create X1EditFieldLabel
            app.X1EditFieldLabel = uilabel(app.UIFigure);
            app.X1EditFieldLabel.HorizontalAlignment = 'right';
            app.X1EditFieldLabel.Position = [111 248 25 22];
            app.X1EditFieldLabel.Text = 'X1';
            % Create X1Edit
            app.X1Edit = uieditfield(app.UIFigure, 'numeric');
            app.X1Edit.Position = [151 248 162 22];
            app.X1Edit.Value = 2;
            % Create X2EditFieldLabel
            app.X2EditFieldLabel = uilabel(app.UIFigure);
            app.X2EditFieldLabel.HorizontalAlignment = 'right';
            app.X2EditFieldLabel.Position = [321 248 25 22];
            app.X2EditFieldLabel.Text = 'X2';
            % Create X2Edit
            app.X2Edit = uieditfield(app.UIFigure, 'numeric');
            app.X2Edit.Position = [361 248 167 22];
            app.X2Edit.Value = 4;
            % Create YEditFieldLabel
            app.YEditFieldLabel = uilabel(app.UIFigure);
            app.YEditFieldLabel.HorizontalAlignment = 'right';
            app.YEditFieldLabel.Position = [266 173 25 22];
            app.YEditFieldLabel.Text = 'Y';
            % Create YEdit
            app.YEdit = uieditfield(app.UIFigure, 'numeric');
            app.YEdit.Position = [306 173 100 22];
            % Create ComputeButton
            app.ComputeButton = uibutton(app.UIFigure, 'push');
            app.ComputeButton.ButtonPushedFcn = createCallbackFcn(app,
@ComputeButtonPushed, true);
            app.ComputeButton.Position = [265 70 162 36];
            app.ComputeButton.Text = 'Compute';
        end
    end
    methods (Access = public)
        % Construct app
        function app = SJ
            % Create and configure components
            createComponents(app)
```

```
            % Register the app with App Designer
            registerApp(app, app.UIFigure)
            if nargout == 0
                clear app
            end
        end
        % Code that executes before app deletion
        function delete(app)
            % Delete UIFigure when app is deleted
            delete(app.UIFigure)
        end
    end
end
```

Conclusion

The study shows the presence of oil spillage in drinking water, soil strata and the marine state. However, the movement or seepage of spill from one medium to another creates different view of life due to its signals to the larger society. A lot of rural dwelers depend upon the well water as a means of sustainability but unknown to them, the underground movement of the spill affects them through the drinking water which in turn affect their quality of life in the dormain of operation. Consequently, the deterministic procedures employed and that of remote sensing application duly satified the study in the Kalabari kingdom.

Recommendations.

The study serves as a light to the academia that, there is always a relationship in space between oil spill, drinking water, soil and temperature that do co-exist in life. After a wide range of study, the following recommendations are necessary:

1. Community youths engaged in illegal bunkering should put an end to bunkering due to the adverse effect.
2. The oil-bearing Communities should be educated on the effect of spillage. Therefore, everybody should be a watchdog to oil installations. Particularly, youths should be engaged to secure oil facilities in the operational areas.

3. The drinking and seawaters should be guided against the emanation of the spill because it goes against the natural state of wellbeing

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